

Instability in Social Dilemma Games: Experimental Evidence

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論文内容の要旨

Starting from the discovery of “prisoner’s dilemma” (originally framed by Merrill Flood and Melvin Dresher in 1950), in more than half a century, a lot of economic researches devoted to study the problem of social dilemma. The social dilemma refers to a situation in which individuals in a group profit from self-interested action unless everyone in the group chooses the selfish alternative, then which results in the loss of the whole group. In experimental economics, based on the basic game of the prisoner’s dilemma, the voluntary contribution mechanism (VCM) and the common-pool resources (CPR) successively have been proposed. Each of them attempts to capture the conflict between the individual interest and the group interest in different situations. Because of the concise of the game theory framework, all of those previous studies employed an equilibrium analysis based on the core concept of Nash equilibrium in the game theory. However, they overlooked the discussion for the stability of the Nash equilibrium in such games. Once the Nash equilibrium is unstable, the equilibrium analysis is invalid.

Recently, Saijo (2014, 2015) and Saijo et al. (2016) investigated the stability property in both the VCM and the CPR situations. Through a dynamic analysis, the Nash equilibrium is unstable or non-globally stable under some particular conditions. Furthermore, by examining previous experimental studies, he found that a lot of published literature using the equilibrium analysis actually employed an experimental design in which the Nash equilibrium is unstable. This result raises a doubt whether the results from previous experimental studies are valid.

In order to determine the implications of this new theoretical insight in the field of experimental studies, in this thesis, we employ the methodology of experimental economics. Specifically, we design new experiments or reanalyze the data from previous experimental studies to examine the distance between theoretical predictions of Saijo (2014, 2015) and Saijo et al. (2016) and experimental observations.

First, we conduct a new experiment with a homogeneous design to investigate the dynamic pattern of contributing behavior in the VCM with two different quasi-linear payoff

functions. The design of this study is based on the theory of Saijo (2014). As the theory predicted, one treatment is stable, and the other one is unstable. Although we have not found a clearly unstable pulsing in the group total contribution from the unstable treatment, we found a significant difference in the dynamic patterns of contributing behavior between the two treatments. The experimental results show that, the system is converging to the interior dominant equilibrium in the stable treatment. The average contribution decreases with repeated trials and individual contributions converge and become steady. In contrast, in the unstable treatment, although contributions on average are also decreasing in repeated trials with no clearly unstable pulsing in the group's total contribution, individual contributions diverge and continuously change. Since these observations do not support the hypothesis that the system of the unstable treatment is asymptotically stable, it indicates that only a comparative static analysis might not be suitable for the VCM with this setting. Moreover, the experimental results show an increasing dispersion among individual contributions. The main source of this observation might be due to the presence of conditional cooperators. However, without a precise theoretical background for the interaction among players with several different other-regarding preferences in an unstable VCM environment, this conjecture is hard to be tested. But, on the theoretical basis, our observation regarding the increasing dispersion still indicates the experimental system is not asymptotical stable. In other words, we are missing the theoretical connection between this observation and the theoretical results of instability. This remains as an open question in our study.

Second, based on the theory of Saijo (2015), we introduce the heterogeneity in benefits from the public good into the design of the unstable treatment in the first study and design four treatments with an identical Nash equilibrium, but with different stability properties. We clearly observe significant differences in the belief formation process, the responding process and the convergence of contributing behavior of subjects across the four treatments. The Nash equilibrium is a good predictor for the two globally stable treatments. However, for the two locally stable treatments, it is not. Furthermore, the non-convergence in the two locally stable treatments does not stem from the local stability, but from the changes in both the belief formation process and the responding process of subjects. The main reason is that human subjects changed their strategical thinking in the belief formation process and the responding process in the non-globally stable treatments. This adaptive

change makes the experimental system more stable than the theoretical prediction. As we pointed out in the conclusion of chapter 3, since our experiments chose the simplest design, whether this adaptive change can keep the stability for the system still remains unknown in the experimental design with more than three players in the group.

Third, I turn to the instability in the CPR. Based on the theory of Saijo et al. (2016), we reanalyze the data from the previous studies. We make a connection between the new insight of local instability and the unexplained pulsing behavior among players. Moreover, the reanalysis shows that the local instability is also a reason for the inefficiency in experiments summarized by Ostrom et al. (2006). The argument of instability can at least partially explain the pulsing behavior in the group sum. However, due to the extent to which players are myopic in the experiments still remains a distance to the theoretical assumption of best response dynamics, the stability property of the experimental system is still remained in unknown. But, we clearly show that the pulsing behavior induces additional inefficiency in the CPR.

Overall, via the experimental studies, we find some consistent results corresponding to the theoretical predictions. More importantly, the inconsistent results reflect some flaws in the theoretical assumptions. First, these observations point the way for the refinement of assumptions in the next step. Especially, it is necessary to build up a theory regarding the interaction of several different social oriented players in a nonlinear VCM environment. Second, the experimental evidence show that some theoretical predictions, i.e. unequal payoff distributions among players and inefficiency from the pulsing, point out new problems in social dilemma games, which stem from the instability. These new findings deserve more theoretical and empirical investigations in the future. Third, generally speaking, the uncertainty to decision-makers is greater in an unstable game environment than in a stable game environment. Our finding indicates that human subjects are willing to take more cognitive costs in an unstable game environment. This interesting finding in the second study sheds some new lights in the field of cognition and decision in uncertainty environment.

Finally, based on the insight of instability, these studies firstly reveal some more profound understanding regarding the social dilemma games than previous studies. However, they also show that the related works are still in the initial stage.